

Pune Vidyarthi Griha College of Engineering
and Technology Pune

DIGITAL SIGNAL PROCESSING

Application Assignment Image Steganography Using DWT

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2. Software/Platform used
3. Steps to install and run the code
4. Stepwise windows screenshots
5. Block Diagram
6. Algorithm used
7. Observation
8. Conclusion
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1.Title

Image Steganography Using DWT

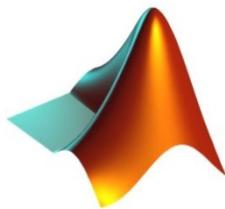
2.Software/Platform used

Coding: MATLAB [R2021A]

Toolbox: Image toolbox,DSP toolbox

3.Steps to Download, install & run the code

MATLAB SIMULINK



MathWorks introduced Release 2021a of the MATLAB and Simulink product families. Release 2021a (R2021a) offers hundreds of new and updated features and functions in MATLAB® and Simulink®, along with three new products and 12 major updates. New capabilities in MATLAB include dynamic controls in live scripts as well as a new task for adding plots to live scripts without writing any code. Simulink updates enable users to import C code as reusable Simulink libraries and to speed up simulations. R2021a also introduces new products in the areas of satellite communications, radar, and DDS applications.

About MathWorks

MathWorks is the leading developer of mathematical computing software. MATLAB, the language of engineers and scientists, is a programming environment for algorithm development, data analysis, visualization, and numeric computation. Simulink is a block diagram environment for simulation and Model-Based Design of multidomain and embedded engineering systems. Engineers and scientists worldwide rely on these product families to accelerate the pace of discovery, innovation, and development in automotive, aerospace, electronics, financial services, biotech-pharmaceutical, and other industries. MATLAB and Simulink are also fundamental teaching and research tools in the world's universities and learning institutions. Founded in 1984, MathWorks employs more than 5000 people in 16

countries, with headquarters in Natick, Massachusetts, USA. For additional information, visit mathworks.com.

1. **Log in or create account**
2. **Choose your trial package**
3. **Download and install**

For downloading MAtlab one should have an email acoount registered with the matlab.

Link for rgistretion to download trial software for 30 days trial:

https://in.mathworks.com/mwaccount/register?form_type=trial&&uri=https%3A%2F%2Fin.mathworks.com%2Fcampaigns%2Fproducts%2Ftrials.html%3Fprodcode%3DML

The screenshot shows the MathWorks website for a free 30-day trial. At the top, it says "Free MATLAB Trial" and features a large banner with the text "Get Started Now with Your Free 30-Day Trial". Below the banner, there's a section for students and a link to check for campus licenses. On the right, there's a "Download Trial Software" section where users can enter their contact information. The URL in the browser bar is https://web.whatsapp.com.

Fill all important information

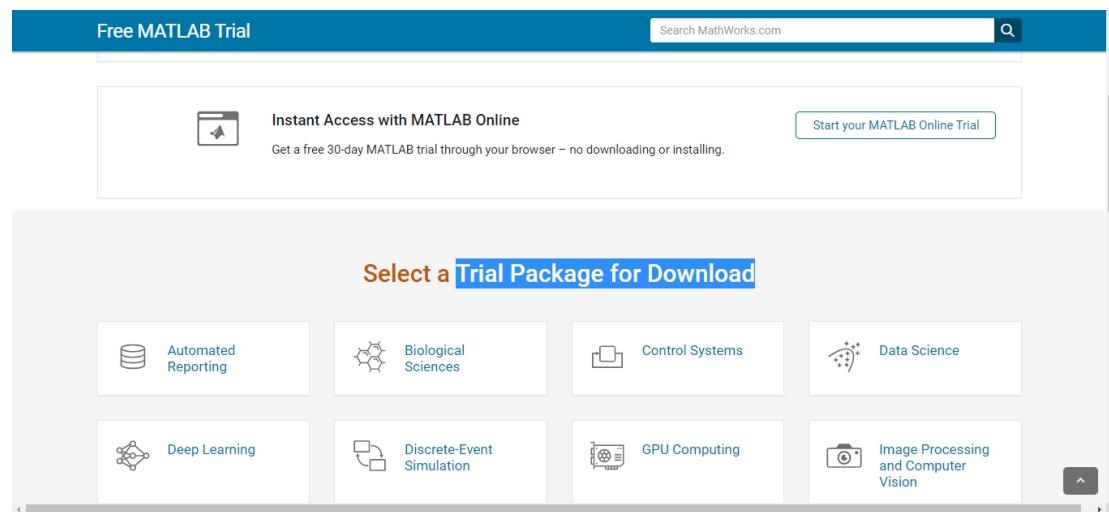
The screenshot shows the MathWorks Account creation page. It prompts the user to "Create a MathWorks Account to continue with your product trial." The form requires the user to enter their Email Address (mr.surajswamy@gmail.com), Location (India), and best description (Student). There's also a question about age ("Are you at least 13 years or older?") with options "Yes" and "No". At the bottom, there are "Cancel" and "Create" buttons.

After creating an account , you will get the conformation link and then log in into your account.

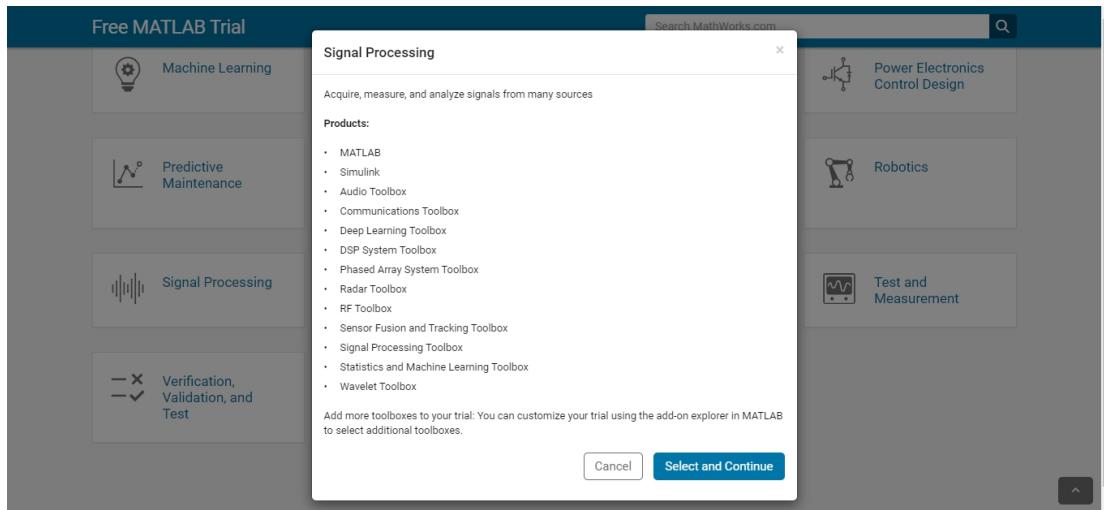
After that click on 'I agree' and submit

The screenshot shows the 'Free MATLAB Trial' page. On the left, there's a sidebar with steps: 1. Log in or create account, 2. Choose your trial package, 3. Download and install. Below this is a box asking if you're a student, with a 'Check for campus license' button. On the right, the main area is titled 'Download Trial Software'. It has a field for 'Work or university email' containing 'mr.surajswamy@gmail.com'. A checkbox labeled 'By clicking 'I agree', I confirm that I will use the products only to evaluate them for possible purchase as an end user.' is checked. A radio button labeled 'I agree.' is also checked. A 'Submit' button is present. Below the form, a note states: 'We will not sell or rent your personal contact information. See our privacy policy for details.'

After that you will get the window for 'Trial Package for Download'



Scroll down and select the 'signal processing ' package as per our project requirement & you will get the screen as like

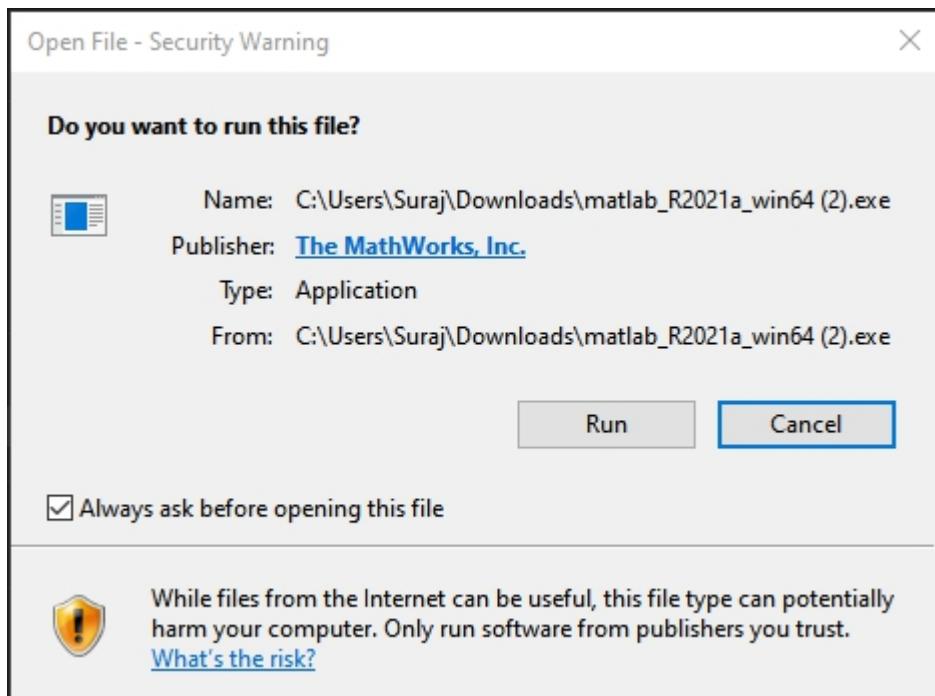


Click on 'select and continue'

A screenshot of the MathWorks download page for R2021a. The top navigation bar includes the MathWorks logo, a search bar, and links for "Downloads", "About R2021a", and "Contact support". The main content area shows the "Select Release" dropdown set to "R2021a". Below it is a section titled "Get MATLAB and Simulink Products" which states: "R2021a Trial 9203527 has been successfully created. This trial expires on 25 Jul 2021." It provides links for "Getting Started with MATLAB", "Getting Started with Simulink", and "Documentation (Help Center)". A prominent blue button labeled "Download for Windows (227 MB)" is shown, with a note below it stating "Includes R2021a Update 3".

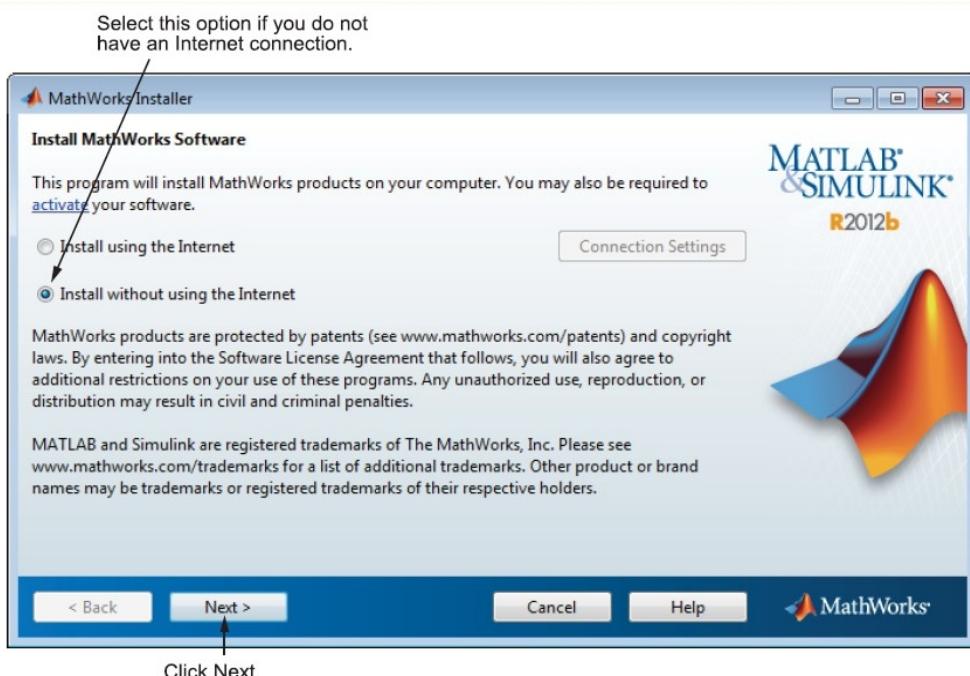
Click on 'Download for Windows' , the 227MB file will be download as per our OPERATING SYSTEM.

Once the file get downloaded select to open and run



After this INSTALLATION process starts

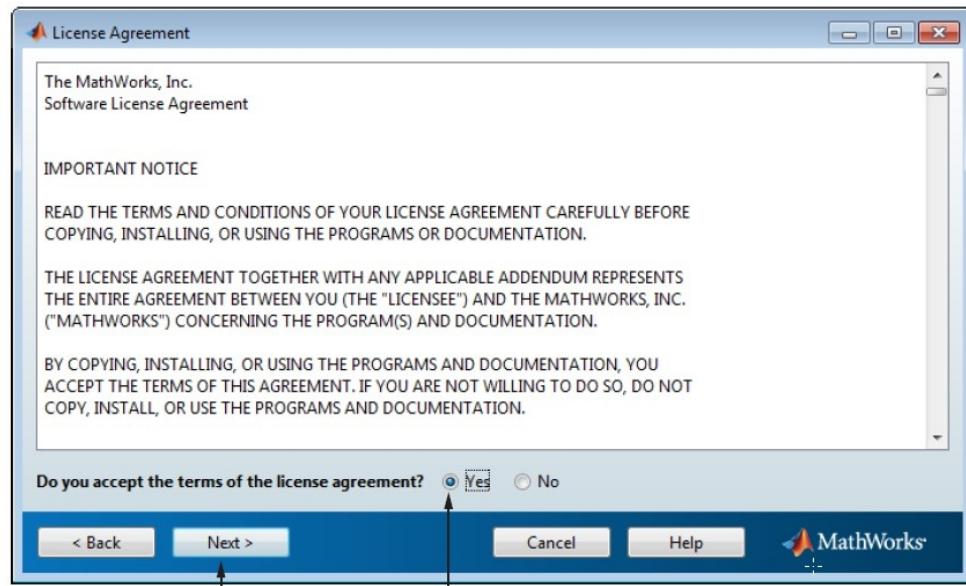
The installer displays the following dialog box. Select the Install without using the Internet option and Click OK to proceed with installation.



Click Next.

Review the License Agreement

Review the software licensing agreement and, if you agree to its terms, click Yes.



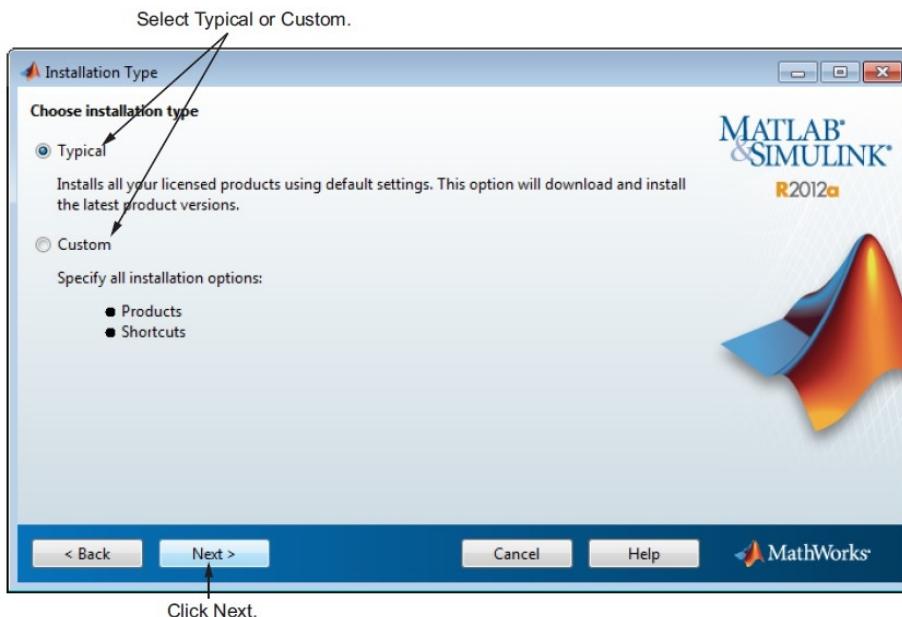
Click Next.

Select Yes.

Enter your File Installation Key and click ok.

Choose the Installation Type

In the Installation Type dialog box, specify whether you want to perform a Custom installation and click Next.

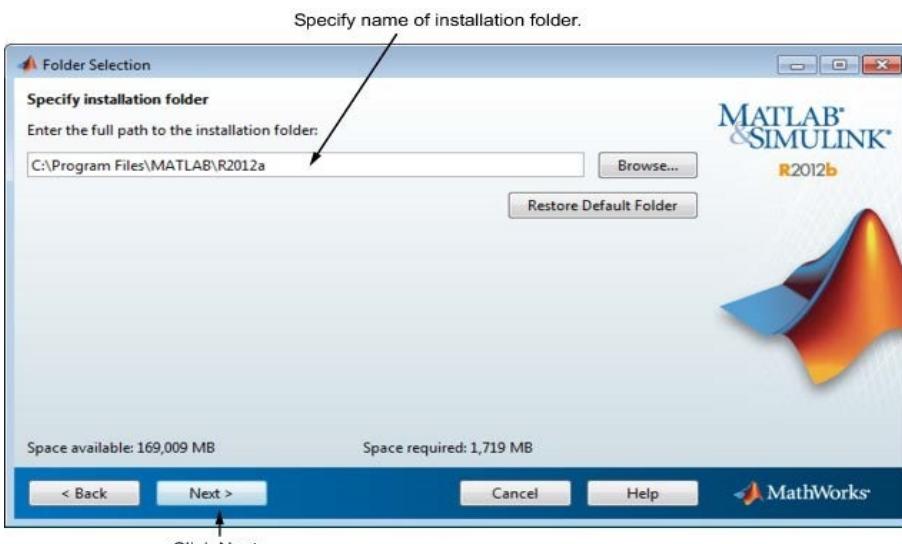


Click Next.

Specify the Installation Folder

Specify the name of the folder where you want to install MathWorks products.

Accept the default installation folder or click Browse to select a different one. If the folder doesn't exist, the installer creates it.



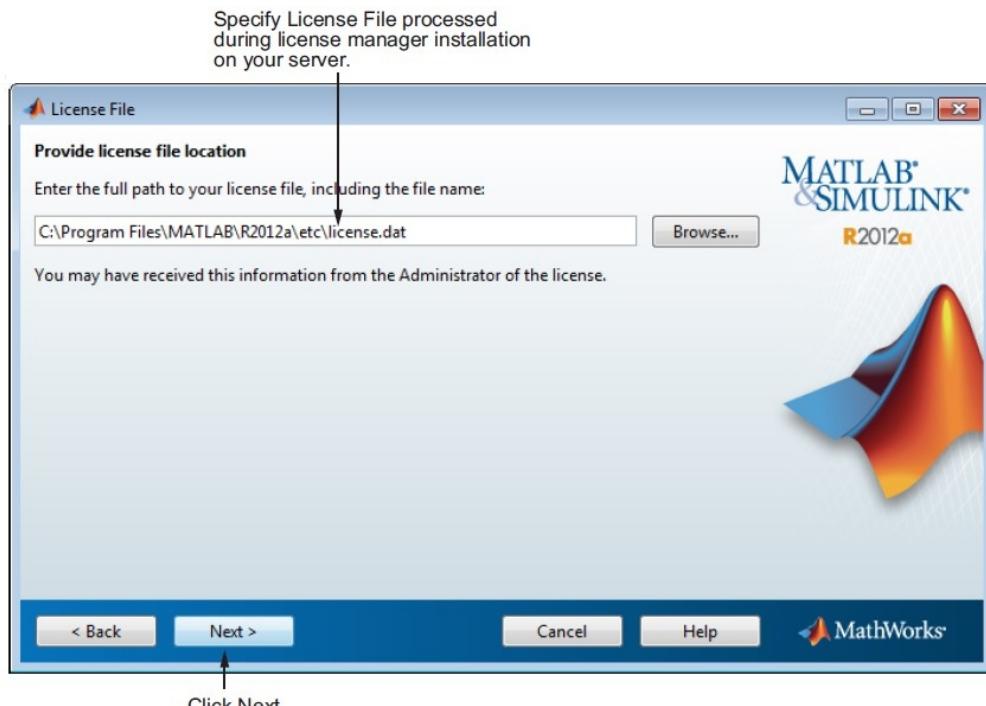
Click Next.

Specify Products to Install (Custom Only)

Leave it by default and continue. After that,

Specify the Location of the License File

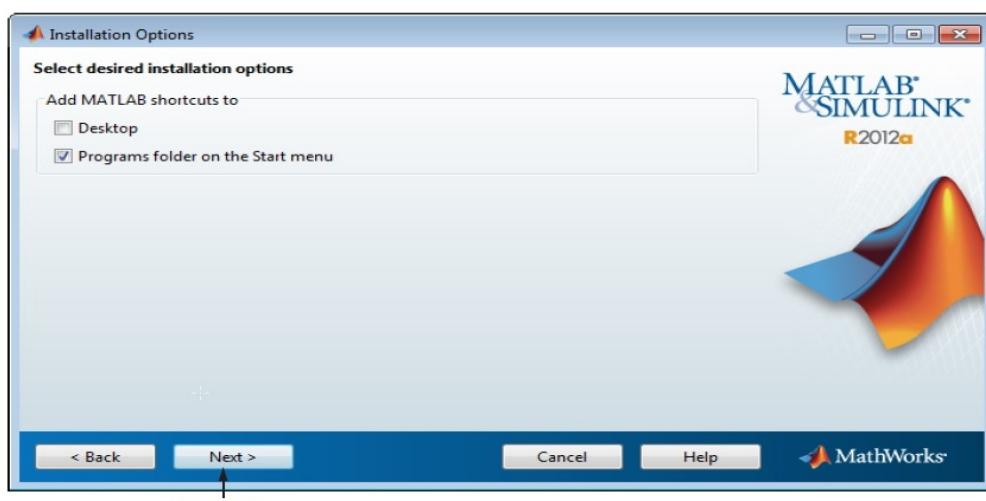
Enter the full path of your License File in the text box (or drag and drop the file) and click Next.



Click Next.

Specify Installation Options (Custom Only)

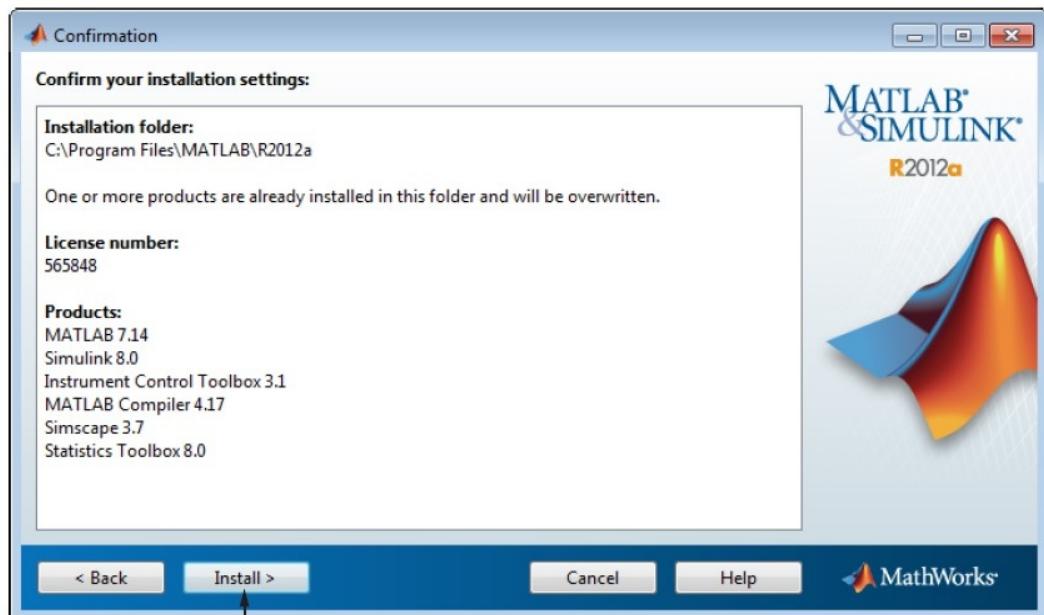
After selecting installation options, click Next to proceed with the installation.



Click Next.

Confirm Your Choices and Begin Copying Files

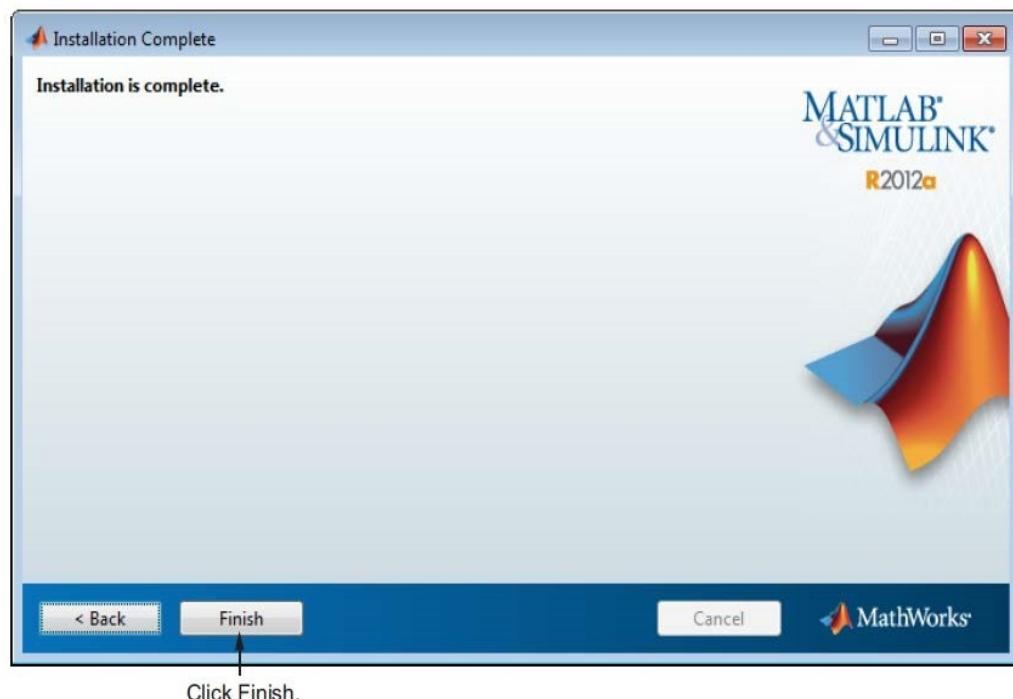
Before it begins copying files to your hard disk, the installer displays a summary of your installation choices. To change a setting, click Back. To proceed with the installation, click Install.



Click Install.

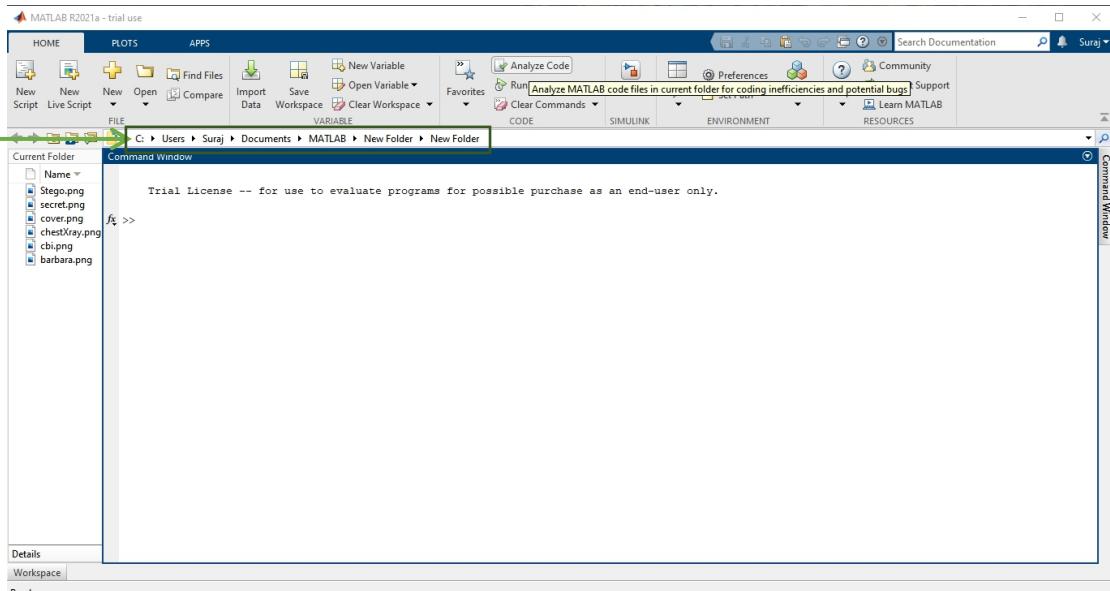
As it copies files to your hard drive, the installer displays a status dialog box to show the progress of the installation.

Complete the Installation

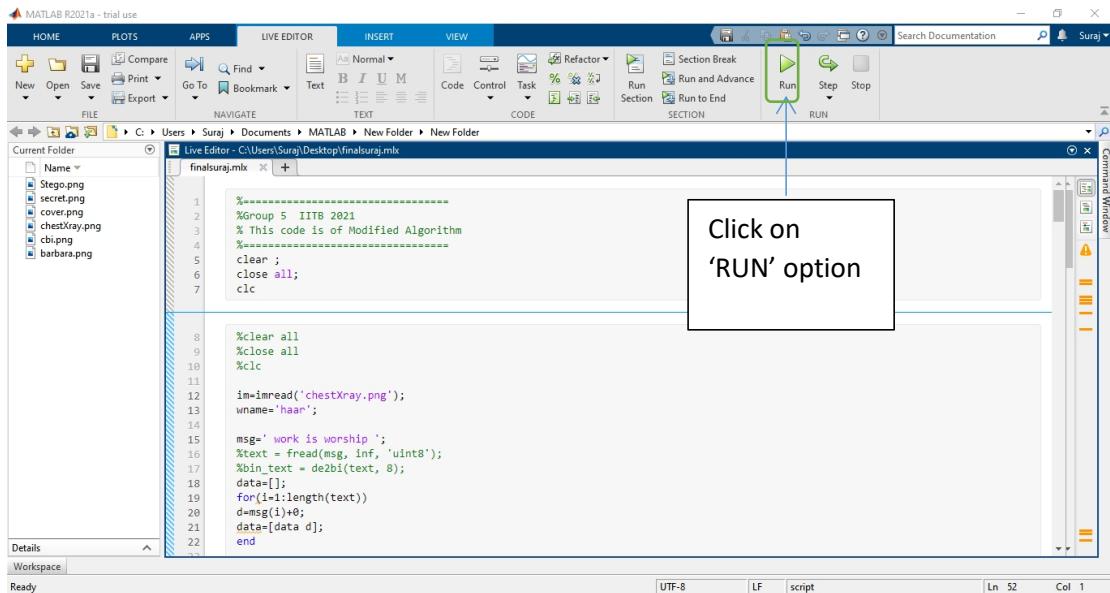


Click Finish.

Now we are ready to open the MATLAB on our desktop



Take a 'live editor' from Home tool and open the project code



4. STEPWISE SCREENSHOT OF WORKING OF PROJECT

Screenshot 1: Initial MATLAB Environment

The MATLAB interface shows the 'Live Editor' window open with the file 'finalsuraj.mlx'. The code reads a chest X-ray image ('chestXray.png') and performs a Haar wavelet transform ('haar'). The resulting approximation coefficients are displayed as a grayscale image.

```
%clear all
%close all
%clc

im=imread('chestXray.png');
wname='haar';

msg='work is worship';
text=fread(msg,inf,'uint8');
bin_text=de2bi(text,8);
data=[];
for i=1:length(text)
    d=msg(i);
    d=msg(i)>0;
    data=[data d];
end

[cA1,cH1,cV1,cD1]=dwt2(im,wname);
dec1=[cA1 cH1;
cV1 cD1];

```

Screenshot 2: Cover and Secret Image Selection

The 'Live Editor' window shows code for reading a stego image ('stego.png') and a secret image ('barbara.png'). Both images are converted to grayscale. The 'Cover Image' is resized to 0.5, while the 'Secret Image' is also resized to 0.5. The resulting images are displayed side-by-side.

```
CoverImage=imread('stego.png');
SecretImage=imread('barbara.png');

CoverImage=rgb2gray(CoverImage);
SecretImage=rgb2gray(SecretImage);

CoverImage=imresize(CoverImage,0.5);
SecretImage=imresize(SecretImage,0.5);

figure(1);
subplot(1,2,1);
imshow(CoverImage);
title('Cover Image');

subplot(1,2,2);
imshow(SecretImage);
title('Secret Image');
```

Screenshot 3: DWT of Cover Image

The 'Live Editor' window shows the Haar wavelet transform ('dwt2') of the 'Cover Image'. The code displays four resulting components: Approximation Coefficients, Horizontal Detail Coefficients, Vertical Detail Coefficients, and Diagonal Detail Coefficients.

```
// imshow(SecretImage);
// title('Secret Image');

DWT of Cover Image

[ICA,ICH,ICV,ICD]=dwt2(CoverImage, 'haar');

figure(2);
subplot(2,2,1);
imshow(mat2gray(ICA));
title('Approximation Coefficients');

subplot(2,2,2);
imshow(mat2gray(ICH));
title('Horizontal Detail Coefficients');

subplot(2,2,3);
imshow(mat2gray(ICV));
title('Vertical Detail Coefficients');

subplot(2,2,4);
imshow(mat2gray(ICD));
title('Diagonal Detail Coefficients');
```

MATLAB R2021a - trial use

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

FILE New Open Save Print Export Go To Bookmarks Text B I U M Code Control Task % Run and Advance Insert app to perform task and generate code Section Break Run and Advance Run Step Stop SECTION RUN

Current Folder C:\Users\Suraj\Documents\MATLAB>New Folder>New Folder

Live Editor - C:\Users\Suraj\Desktop\finalsuraj.mlx

```

95 imshow(mat2gray(ICD));
96 title('Diagonal Detail Coefficients');

DWT of Secret Image

97 [SCA,SCH,SCV,SCD] = dwt2(SecretImage, 'haar');
98 figure(3);
99 subplot(2,2,1);
100 imshow(mat2gray(SCA));
101 title('Approximation Coefficients');
102
103 subplot(2,2,2);
104 imshow(mat2gray(SCH));
105 title('Horizontal Detail Coefficients');
106
107 subplot(2,2,3);
108 imshow(mat2gray(SCV));
109 title('Vertical Detail Coefficients');
110
111 subplot(2,2,4);
112 imshow(mat2gray(SCD));
113 title('Diagonal Detail Coefficients');
114

```

Approximation Coefficients
Horizontal Detail Coefficients
Vertical Detail Coefficients
Diagonal Detail Coefficients

Details Workspace Ready

MATLAB R2021a - trial use

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

FILE New Open Save Print Export Go To Bookmarks Text B I U M Code Control Task % Run and Advance Insert slider, drop down, or other control in to End Section Break Run and Advance Run Step Stop SECTION RUN

Current Folder C:\Users\Suraj\Documents\MATLAB>New Folder>New Folder

Live Editor - C:\Users\Suraj\Desktop\finalsuraj.mlx

```

Embedding

115 m=4;
116 BS = mat2cell(SCA,repmat(m,1,size(SCA,1)/m), repmat(m,1,size(SCA,2)/m));
117 BC = mat2cell(ICA,repmat(m,1,size(ICA,1)/m), repmat(m,1,size(ICA,2)/m));
118 BD = mat2cell(ICD,repmat(m,1,size(ICD,1)/m), repmat(m,1,size(ICD,2)/m));
119
120 BS = reshape(BS,1,size(BS,1)*size(BS,2));
121 BC = reshape(BC,1,size(BC,1)*size(BC,2));
122 BD = reshape(BD,1,size(BD,1)*size(BD,2));
123
124 EB=BS;
125
126 K1 = zeros(1,size(BS,2));
127 K2 = zeros(1,size(BS,2));
128 K3=100;
129 MSE1 = zeros(size(BS,2),size(BC,2));
130 MSE2 = zeros(size(BS,2),size(BC,2));
131 for i=1:size(BS,2)
132     for j=1:size(BC,2)
133         if any(ismember(K1,j))
134             MSE1(i,j)=999999;
135         else
136             MSE1(i,j) = immse(BS{i},BC{j});
137         end

```

Stego Image Original Cover Image

Details Workspace

MATLAB R2021a - trial use

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

FILE New Open Save Print Export Go To Bookmarks Text B I U M Code Control Task % Run and Advance Insert app to perform task and generate code Section Break Run and Advance Run Step Stop SECTION RUN

Current Folder C:\Users\Suraj\Documents\MATLAB>New Folder>New Folder

Live Editor - C:\Users\Suraj\Desktop\finalsuraj.mlx

```

138 MSE1(i,j) = immse(BS{i},BC{j});
139 end
140 [~,K1(i)]=min(MSE1(i,:));
141 EB{i}=(BC{K1(i)})-BS{i})/K3;
142
143 for i=1:size(EB,2)
144     for k=1:size(BD,2)
145         if any(ismember(K2,k))
146             MSE2(i,k) = 999999;
147         else
148             MSE2(i,k) = immse(EB{i},BD{k});
149         end
150     end
151     [~,K2(i)]=min(MSE2(i,:));
152     BD{K2(i)}=EB{i};
153 end
154
155 BS = reshape(BS,size(SCA,1)/m, size(SCA,2)/m);
156 BC = reshape(BC,size(ICA,1)/m, size(ICA,2)/m);
157 BD = reshape(BD,size(ICD,1)/m, size(ICD,2)/m);
158
159 mICA=ICA;
160 mICD=ICD;
161

```

Stego Image Original Cover Image

Details Workspace

Matlab R2021a - trial use

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

FILE New Open Save Print Export Go To Bookmarks Text B I U M

NAVIGATE TEXT CODE Control Task % Run Run and Advance SECTION RUN

Live Editor - C:\Users\Suraj\Desktop\finalsuraj.mlx

Current Folder

```

151 [~,K2{1}]=min(M5E2{i,:});
152 BD{K2{1}}=EB{1};
153 end
154
155 BS = reshape(BS,size(SCA,1)/m,size(SCA,2)/m);
156 BC = reshape(BC,size(ICA,1)/m,size(ICA,2)/m);
157 BD = reshape(BD,size(ICD,1)/m,size(ICD,2)/m);
158
159 mICA=ICA;
160 mICH=ICH;
161 mICV=ICV;
162 mICD=cell2mat(BD);
163
164 SteganoImage=idwt2(mICA,mICH,mICV,mICD,'haar');
165
166 figure(4);
167 subplot(1,2,1);
168 imshow(mat2gray(SteganoImage));
169 title('Stego Image');
170
171 subplot(1,2,2);
172 imshow(mat2gray(idwt2(ICA,ICH,ICV,ICD,'haar')));
173 title('Original Cover Image');

```

Stego Image Original Cover Image

Details Workspace

UTF-8 LF script Ln 237 Col 1

Matlab R2021a - trial use

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

FILE New Open Save Print Export Go To Bookmarks Text B I U M

NAVIGATE TEXT CODE Control Task % Run Run and Advance SECTION RUN

Live Editor - C:\Users\Suraj\Desktop\finalsuraj.mlx

Current Folder

```

170 subplot(1,2,2);
171 imshow(mat2gray(idwt2(ICA,ICH,ICV,ICD,'haar')));
172 title('Original Cover Image');



### Extraction


173
174 [GCA,GCH,GCV,GCD] = dwt2(SteganoImage, 'haar');
175 figure();
176 %subplot(1,2,1);
177 imwrite(CoverImage,'cbi.png')
178 imshow(CoverImage);
179 title('Cover Image');
180
181 %subplot(1,2,2);
182 imshow(SecretImage);
183 title('Secret Image');



### DWT of Cover Image


184 [ICA,ICH,ICV,ICD] = dwt2(CoverImage, 'haar');
185
186 figure(5);

```

Cover Image Secret Image

Details Workspace

UTF-8 LF script Ln 237 Col 1

Matlab R2021a - trial use

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

FILE New Open Save Print Export Go To Bookmarks Text B I U M

NAVIGATE TEXT CODE Control Task % Run Run and Advance SECTION RUN

Live Editor - C:\Users\Suraj\Desktop\finalsuraj.mlx

Current Folder

```


### DWT of Cover Image


187 [ICA,ICH,ICV,ICD] = dwt2(CoverImage, 'haar');
188
189 figure(5);
190 subplot(2,2,1);
191 imshow(mat2gray(GCA));
192 title('Approximation Coefficients');
193
194 subplot(2,2,2);
195 imshow(mat2gray(GCH));
196 title('Horizontal Detail Coefficients');
197
198 subplot(2,2,3);
199 imshow(mat2gray(GCV));
200 title('Vertical Detail Coefficients');
201
202 subplot(2,2,4);
203 imshow(mat2gray(GCD));
204 title('Diagonal Detail Coefficients');
205
206 eBD = mat2cell(GCD,repmat(m,1,size(GCH,1)/m),repmat(m,1,size(GCH,2)/m));
207 eBC = mat2cell(GCH,repmat(m,1,size(GCA,1)/m),repmat(m,1,size(GCH,2)/m));
208 eBS = cell(1,size(K1,2));

```

Approximation Coefficients Horizontal Detail Coefficients

Vertical Detail Coefficients Diagonal Detail Coefficients

Details Workspace

UTF-8 LF script Ln 237 Col 1

MATLAB R2021a - trial use

Live Editor - C:\Users\Suraj\Desktop\finalsuraj.mlx

```

Current Folder
Name
Stego.png
secret.png
cover.png
chestXray.png
cbi.png
barbara.png

finalsuraj.mlx + 207
eBC = reshape(eBC,1,size(eBC,1)*size(eBC,2));
eBD = reshape(eBD,1,size(eBD,1)*size(eBD,2));

for i=1:size(K1,2)
    eBS(i)=eBC(K1(i))-K3*eBD(K2(i));
end

eBS = reshape(eBS,size(SCA,1)/m,size(SCA,2)/m);

eSCA=cell2mat(eBS);
eSCH=zeros(size(eSCA));
eSCV=zeros(size(eSCA));
eSCD=zeros(size(eSCA));

eSecretImage=idwt2(eSCA,eSCH,eSCV,eSCD,'haar');

figure(6);
subplot(1,2,1);
imshow(mat2gray(eSecretImage));
title('Extracted Secret Image');

subplot(1,2,2);
imshow(mat2gray(idwt2(SCA,SCH,SCV,SCD,'haar')));
title('Original Secret Image');

```

Extracted Secret Image Original Secret Image

MATLAB R2021a - trial use

Live Editor - C:\Users\Suraj\Desktop\finalsuraj.mlx

```

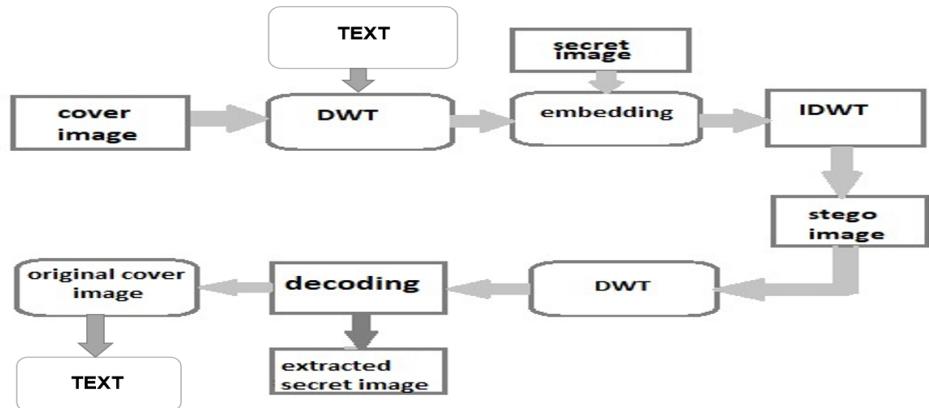
Current Folder
Name
Stego.png
secret.png
cover.png
chestXray.png
cbi.png
barbara.png

finalsuraj.mlx + 233
Extraction Of Text from Cover_image
im=imread('cbi.png');
[cA11,cH11,cV11,cD11] =dwt2(CODED1,'haar');
data=[];
data_norm=[];
n=ceil(abs(cH11(1,1)*10));
M=ceil(abs(cH11(1,2)*10));
for(i=1:ceil(n/2))
    data_norm(i)=cV11(i,y);
end

for(i=ceil(n/2)+1:n)
    data_norm(i)=cD11(i,y);
end
data=cell(data_norm*M)-1;
msg1='';
for(i=1:length(data))
    msg1=strcat(msg,data(i));
end
msg1 = ' work is worship'

```

5. Block diagram:



6.Algorithm: for embedding

1.With the Discrete Wavelet Transform, convert -
the cover image, I, into the 4 subimages: (ICA, ICH, ICV, ICD) and
the secret image, S, into the 4 subimages: (SCA, SCH, SCV, SCD)

2Each of SCA, ICA and ICD are partitioned into 4x4 pixels -

$$SCA = \{BS_i, 1 \leq i \leq ns\}$$

$$ICA = \{BC_j, 1 \leq j \leq nc\}$$

$$ICD = \{BD_k, 1 \leq k \leq nc\}$$

where BS_i , BC_j and BD_k represent the ith block in SCA, jth block in ICA, kth block in ICD respectively, ns is the total number of 4×4 blocks in SCA and nc is the total number of the 4×4 blocks in each of ICA and ICH.

3.For each block BS_i in SCA, the best matched block BC_j of minimum error in ICA is searched by using the root mean squared error (RMSE).

The first secret key K1 consisting of the addresses, j , of the best matched blocks in ICA.

4.Calculate the error block EB_i between BS_i and BC_j as follows:

$$EB_i = (BC_j - BS_i) / K3$$

Where $K3$ is a secret key chosen randomly between 100 and 170.

5.For each error block EB_i , the best matched block BD_k in ICD is searched for using the RMSE criteria as before, and that BD_k is replaced with the error block EB_i .

The second secret key K2 consists of the addresses, k of the best matched blocks in ICD.

6.until all the produced error blocks are embedded in ICD.

7.Apply the inverse DWT to the sub-images - ICA, ICV, ICH and the modified ICD to obtain the stegano image.

Algorithm: for extraction

1. With the Discrete Wavelet Transform, convert the stego image, G, into the 4 subimages: (GCA, GCH, GCV, GCD).

2. The extracted secret image coefficients, eBSi , are obtained by -

$$eBSi = eBCK1(i) - K3 * eBDK2(i)$$

where

$$\{ eBCj \} = GCA$$

$$\{ eBDk \} = GCD$$

3. Repeat Step 2 until all secret blocks are extracted and form the subimage, eSCA, as follows:

$$eSCA = \{ eBSi \}$$

4. Assign each of eSCD, eSCV and eSCH as zeros and apply the inverse DWT to obtain the retrieved Secret Image.

7.Code output:

1. Output of embedding of an text into cover image:



ms = 7.8201e-06

ps = 99.1987

2. images are going to use for the code ‘cover image’ , ’ secret image’ respectively

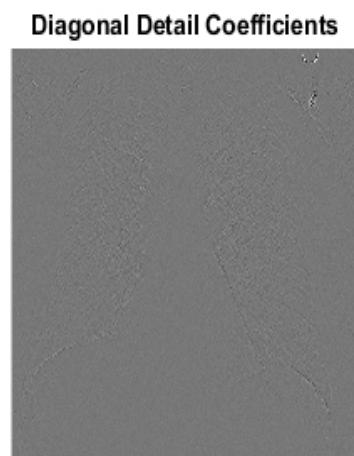
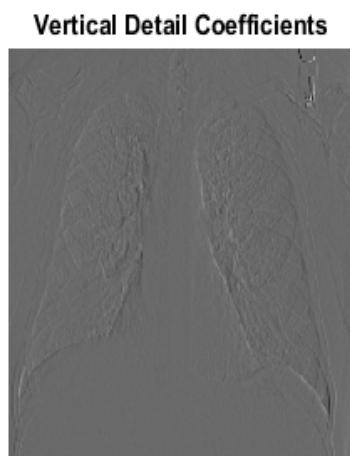
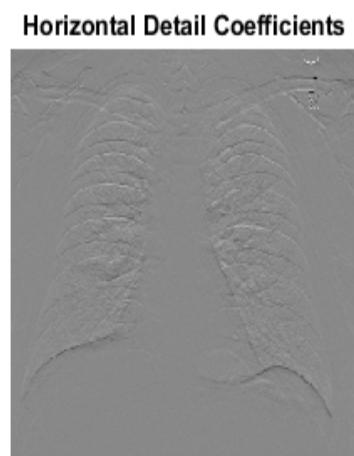
Cover Image



Secret Image



3. DWT of cover image



4. DWT of secret image

Approximation Coefficients



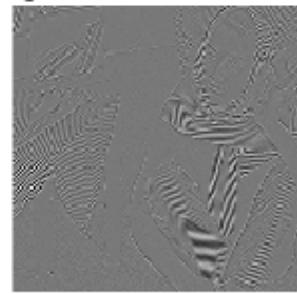
Horizontal Detail Coefficients



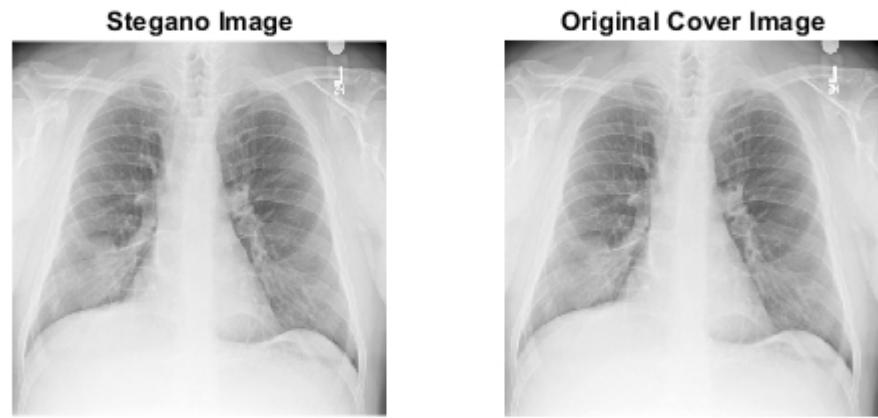
Vertical Detail Coefficients



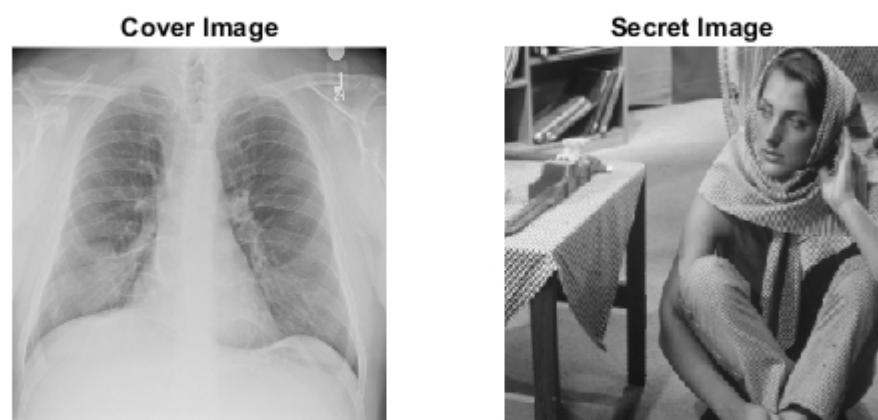
Diagonal Detail Coefficients



5. embedding process is done , and comparisen between embedded image(stegano image) & original cover image



6. Extraction process is completed.

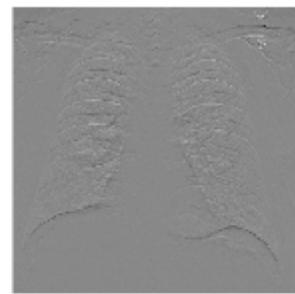


7. After extraction effect on cover image

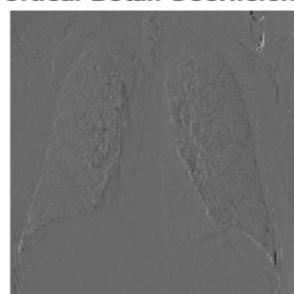
Approximation Coefficients



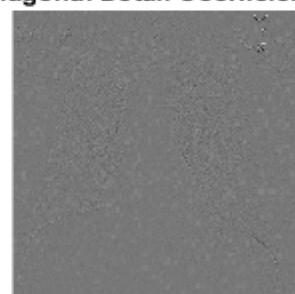
Horizontal Detail Coefficients



Vertical Detail Coefficients



Diagonal Detail Coefficients



Extracted Secret Image



Original Secret Image



8. extraction of TEXT from Cover_Image

```
data =  
[]  
msg1 = ' work is worship'
```

8.Conclusion:

- in our project multi-steganography is possible.
- At 1st text is get embedd into an cover image and after the secret image is get embedded into cover image
- After at extraction stage the secret image is extracted sucessfully from cover image.
- Then secret text is also extracted sucessfully from cover image
- Due to multi_steganography , the secret_text or secret_image can be used as false data and true data respectively or vice-versa. For security purpose.

9. code links:

<https://github.com/mohdshahbaz123/Image-Steganography>

